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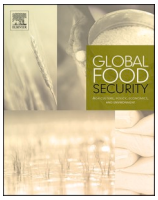

The CGIAR needs a revolution

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ABSTRACT

The CGIAR is a unique scientific organization that seeks to improve food security for low-income people. It should be leading efforts to generate sustainable productivity gains in agriculture, especially in sub-Saharan Africa where productivity lags. However, its current ill-adapted priorities and structure, its obsession with re-organizations, and its unproductive ventures into local development projects have reduced its impact and rendered it unable to respond to the challenge of food security under climate change. The system's efforts have become too diffuse and ineffective while attempts to revive impact through repeated re-organizations have failed. The CGIAR has unique strengths: access to plant germplasm, know-how to improve germplasm and agronomic practices, global networks of experimental sites and research collaborators, and excellent staff. The CGIAR's scientists are highly motivated, but leaders and funders of the system have failed to support them with a simple, focused, and better funded operational environment needed to succeed in their research – and have greater impact from it. This can be corrected. We propose a scientific and problem-driven focus on fewer global and regional research priorities, supported by adequate long-term funding, rigorous methods of project evaluation, and management that stimulates innovation and seeks verifiable results. These supports do not exist today and we do not see that the current One CGIAR system will provide them in the foreseeable future.

1. Introduction

The Consultative Group on International Agricultural Research (CGIAR, "the system") began in 1971 as a loosely coordinated international collaboration to increase food production in low-income countries. The CGIAR began in 1971 with four International Agricultural Research Centers (IARCs; IRRI in Los Banos, Philippines, formally constituted in 1960; CIMMYT, in Mexico, 1966; CIAT, in Cali, Colombia, 1967; and IITA in Ibadan, Nigeria, 1967). These new institutions were credited with the crop improvements and related innovations that made the 'Green Revolution', particularly in Asia and Latin America (Evenson and Gollin, 2003; Raitzer and Kelley, 2008; Stevenson et al., 2013). New centers in the 1970s sought to replicate the institutional model for other crops and production environments (e.g., ICRISAT for five rainfed crops in the semi-arid tropics, CIP for root and tuber crops, ICARDA for dryland agriculture, and ILCA and ILRAD for African livestock). These efforts led to productivity gains in sorghum, cassava, potato, sweet potato, common beans, cowpea, and pigeonpea. IFPRI was established in 1975 to lead on policy research. By 1983, the system had grown to 13 institutions. The incorporation of new 'environmental' Centers (IWMI for water, ICRAF for agroforestry, CIFOR for forests, Bioversity, and WorldFish) drove membership to 18 b y 1993. During the 2000s, the CGIAR was comprised of 15 Centers, 13 of which are still members of the collective now known as 'One CGIAR'.

Some CGIAR programs have been very successful. The system spent about US$60 billion in net present value (NPV) terms from 1970 through 2020. From that investment it generated US$1.78 trillion in NPV benefits (Alston et al., 2022).[1] Earlier reviews (Alston et al., 2000; Maredia and Raitzer, 2006, 2012) and more recent analysis (Alston et al., 2020; Krishna et al., 2023) found that economic benefits were concentrated in four crops (rice, wheat, cassava, and maize), were generated almost entirely by the founding four centers, particularly CIMMYT and IRRI, and occurred largely before the year 2000 (Fig. 1). Most other centers have contributed only small shares of total returns (Alston et al., 2022). For example, there have been only limited measurable benefits from work at ICRISAT (Winter-Nelson and Mazvimavi, 2014), ICARDA or

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[1] Crops represented in the nine billion-dollar studies of Alston et al. (2020, 2022) of returns to CGIAR work were rice, wheat, cassava, beans, sweet potato and potato.

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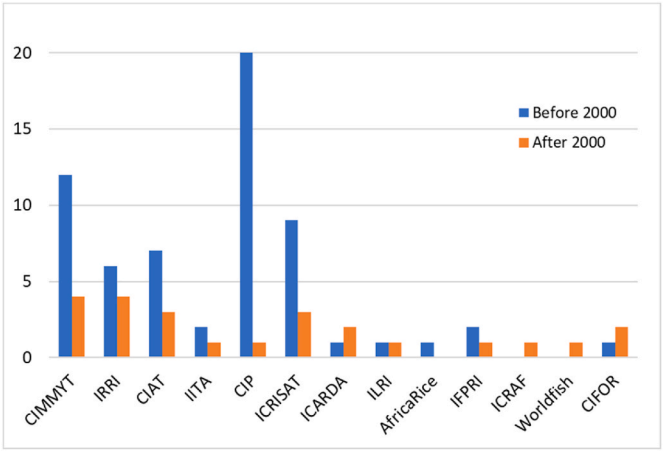

Fig. 1. Number of economic impact studies with internal rates of return (IRR) estimates by CGIAR centers. A few centers generated most of the CGIAR's benefits, and they mostly did it in the 20th century. Source: Created from Annex 1 in Alston et al. (2020).

AfricaRice. Literature reviews[2] found no economic benefits from research at Bioversity, WorldFish, ILRI, or IWMI. The only evidence for economic benefits from recent work at CIFOR and ICRAF is projections from ex-ante models (Coccia et al., 2022), which actual field measurements have not confirmed.

Recent evidence has confirmed our view of the productivity gains associated with CGIAR work. Fuglie and Echeverria (2023) found (p.31, Fig. 3in their report) that crop improvement generated some 86% gains from CGIAR efforts over the period 2016–2020; (ii) 59% of the crop technology gains were observed in Asia (P. 32, Table 1A in their report); (iii) 80% of crop technology gains were from wheat, rice, and maize; (iv) gains from IPM were some 13% of the total, consisting, almost entirely of the work of IITA and collaborators on cassava mealy bug that began in the 1980s; and (v) mean productivity gains of second generation improved cultivars were less than mean gains of first generation cultivars in 19 major crops in sub-Saharan Africa (SSA), East and South Asia, Latin America and the Caribbean, and Central-West Asia/North Africa (Fuglie and Echeverria (2023).

We recognize that attribution to the CGIAR and tracing the full chain of outcomes and impacts of CGIAR research on natural resources management, environment or policy is hampered by formidable methodological challenges (CGIAR ISPC, 2011; Stevenson et al., 2019). Likewise, less direct impact from CGIAR research also arises in many others ways, for example germplasm sharing, capacity building or convening functions of CGIAR centers for bringing together national and sub-regional partners.

The contexts of the CGIAR's work have changed radically since its initial successes. The CGIAR's once dominant role in agricultural innovation has faded as national research and extension programs in some countries have become stronger. Middle-income countries such as China, India, Brazil, or Turkey now command a large share of publicly funded agricultural R&D (Dehmer et al., 2019). Private investment in agricultural research and extension has expanded in crop improvement, precision input use, agronomic practices, mechanization and post-harvest technologies. Information costs have fallen to near-zero, accelerating the transfer of knowledge among political regions and production environments, as well as directly to farmers. Many national agricultural research and extension systems (NARES) in lower-income countries, particularly in SSA, do not have the capacity to take full advantage of new developments in science and technology and a re-orientation of global programs is needed to develop and use that capacity more effectively.

Another shift has occurred in rural production environments, which have evolved under the influences of infrastructure development, technical change in farming and in support industries, and climate change. While expansion in arable land, irrigated areas, use of mineral fertilizers, machinery services, and other inputs drove productivity for decades, growth in input use and land availability has slowed in recent years.

A third evolution is that research problems have become more complex. Growth in total factor productivity (TFP)– a measure of technical efficiency – has slowed, particularly in SSA. Recent decades have seen slowdowns in yield growth rates of the major cereals. Harvested area of the ten major grain, protein, oil, and sugar crops has increased by about 200 million hectares since the early 2000s (Cassman and Grassini, 2020). The contribution of land expansion (much of which has been in SSA) to agricultural output growth more than doubled during 2011–2020 compared to the previous decade, whereas the contributions of input intensification and TFP growth declined (USDA Economic Research Service, 2022). Higher temperatures, more erratic precipitation, and increased risks of extreme climate events will make it more costly to lift productivity, while putting further demands on public social protection spending in response to extreme weather events and pandemics. Agricultural science and innovation are now viewed as drivers of whole food systems transformation (Braun et al., 2023), and malnutrition has evolved from a global burden of under-nutrition to a twin burden of over- and under-nutrition, posing new technical and policy problems (Popkin et al., 2020).

Although global food challenges have not become weaker, it has been challenging for the CGIAR to secure sufficient investments for its research in low- and middle-income countries. Per capita CGIAR spending experienced a period of nearly 20 years of decline or stagnation, and only rose significantly for a few years following the world food price crisis of 2007/8 (Fig. 2).

The CGIAR's response to these long-term trends has been to 'reform' itself. Here we first review these reform attempts, concluding that they have failed. Following this, we make suggestions for a true transformation of the CGIAR in terms of research, governance and funding. Some of our views are similar to those expressed by others long time ago (Lele, 2004) or during the early stages of creating the current One CGIAR (Barrett, 2020), whereas others differ significantly. We do not expect a consensus on what we propose, but we hope to stimulate a more open discussion of the lack of focus and impact in many areas, and to encourage a willingness to re-orient the CGIAR on what it is best at. A background paper presents further evidence for many of the arguments

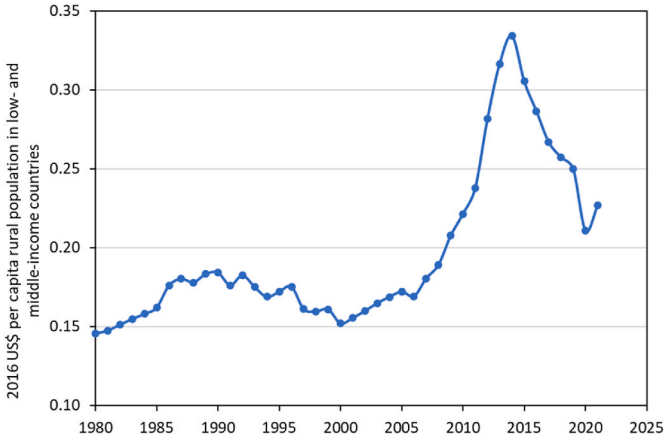

Fig. 2. Annual CGIAR spending per capita rural population in low- and middle-income countries, 1980–2021. Source: Created from Annex 1 in Alston et al. (2020).

[2] Annex 1 in Alston et al. (2020) lists 98 benefit-cost studies attributable to one or more IARCs.

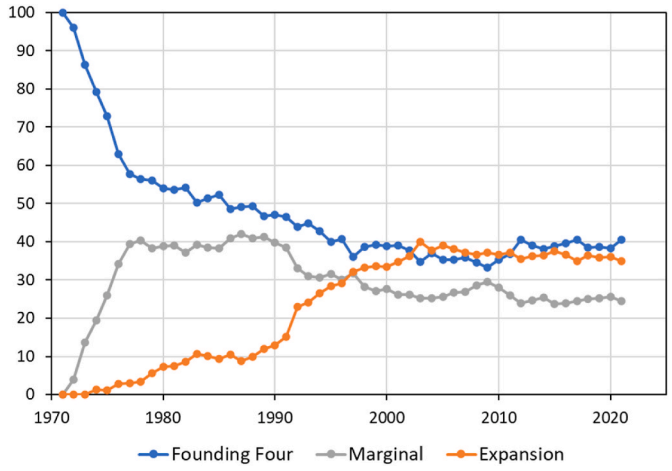

Fig. 3. Shares (%) of CGIAR spending by groups of centers, 1971–2021. Founding Four Centers: IRRI, CIMMYT, CIAT, IITA; Marginal Environments Centers: CIP, ICARDA, ICRISAT, ILRI; Expansion Centers: AfricaRice, Bioversity, CIFOR, ICRAF, IFPRI, IWMI, WorldFish. Source: CGIAR data.

made here (McIntire, 2023).

2. The long decline of the CGIAR

We begin by summarizing the decline of the CGIAR over the past 25 years.

- There was a shift from unrestricted ("core") to restricted funding, beginning in the mid-90s. During the 1980s, unrestricted revenue amounted to 80–85% of Centers' income. The share of unrestricted (or less restricted) funding fell to 27% in the 2011–2021 era and is less than 30% in the current One CGIAR arrangement;
- As real resources fell (roughly from 1996 to 2007 and again from 2014 to 2020), scientists were forced to spend less time on research and more on fund-raising, administration, and managing donor requests;
- Expanding efforts on marginal areas, where "marginal" is defined as regions having lower production potential (e.g. the arid and semi-arid tropics, densely populated highlands) and most often studied under the mandates of CGIAR Centers such as ICARDA, ICRISAT, ILRI, or CIP;
- Under the constant pressure of raising money from many restricted sources, scientists moved away from the mission of global public goods research toward research for development ("R4D") in the hope of satisfying donor expectations about immediate impact; spending on R4D, which is largely technology transfer and extension, bore a heavy opportunity cost in foregone science; indeed, the CRP "synthesis of learning" (Holderness et al., 2021) admitted that "The system-level CRPs using R4D approaches at the field level (e.g., participatory research, action research) faced significant challenges in delivering their intended outputs and outcomes because of unrealistic planning and expectations and/or because their areas of focus were insufficiently innovative for system transformation that would significantly benefit the poor. "
- Insufficient capital investment due to less predictable and more restricted funding, causing an erosion of critical infrastructure;
- The incorporation and expansion of new IARCs in policy, livestock, water, biodiversity, fish and trees compromised funding in the system's areas of comparative advantage (Alston et al., 2022); Less was invested in cereals and food legumes, which had produced nearly all the system returns between 1970 and 2000, whereas more was spent on the newer policy and environmental IARCs after the mid-90s, even though those have demonstrated only small (and often zero) economic returns (Fig. 3);
- The focus on R4D and project management made the system less capable of responding to the scientific challenges of climate change and less able to use newer scientific tools. Increasing bureaucracy imposed higher transactions costs on scientists while repeated and expensive attempts to "evaluate," "consult" and "reform" all failed to address the causes of declining impact;
- The top-down behavior of system management weakened its credibility with scientists, national partners, the private sector and others in identifying priorities, managing programs, defining comparative advantage, and strengthening the national and regional capacities; and
- A massive increase in governance complexity and in management expenditures, including the emergence of a large central unit ("CGIAR System Organization") diverted even more funds from science.
- The growing influence of a diverse range of donors changed the orientation of the CGIAR and led to micro-management of investments and programs that do not originate from scientific analysis but from donors' domestic political and academic priorities.

The CGIAR community—scientists, administrators, donors, partners—has made several attempts to reverse the system's decline. The World Bank commissioned a meta-analysis (Lele, 2004) to understand the successes and failures of the first three decades. That paper's most striking, and enduring, conclusion was that "[the CGIAR's] current mix of activities reflects neither its comparative advantage nor its core competence". The meta-analysis made four principal recommendations to return the system to its core mandate and to raise impact: (i) increase unrestricted funding, to allow more stability in research planning and execution, while reducing transactions costs; (ii) reallocate funding to germplasm improvement and other productivity-enhancing innovations, which had been the sources of historical gains; (iii) devolve some policy and natural resources work to national and regional programs, given that the demand for such work reflects local economic, biological and social conditions; and (iv) consolidate the numbers and functions of centers, so as to reduce overhead and to permit more effective collaboration. These recommendations were not seriously pursued. The unrestricted funding, reallocation, and devolution recommendations were ignored as restricted funding continued to dominate, as resources moved from productive centers to unproductive ones, and as many IARCs continued jobs that others could have done more efficiently. Efforts to improve collaboration among IARCs did not raise impact, as seen in the experiences of 17 Systemwide Programs (1993–2010), 5 Challenge Programs (2003–2010), and 16 CGIAR Research Programs and Platforms (2011–2021).

The continued decline of the system led to a subsequent "Independent Review" (CGIAR Independent Review Panel, 2008). The review admitted that previous reforms had failed. It made six operational recommendations with the goals of higher and less restricted funding, improved collaboration among CGIAR scientists and partners, and sharper effectiveness and efficiency. Responding to the conclusion of the "Independent Review" that "… the CGIAR is falling short of its potential in addressing the new and emerging global challenges, and risks rapid loss of relevance" (CGIAR, 2008), a new reform package contained these elements.

- A Strategy and Results Framework (CGIAR, 2011) with four system outcomes—reduction in poverty, increased global food security, improvement of nutrition and better management of natural resources—to be implemented from 2011/12 through 16 new Consortium Research Programs (CRPs) and Platforms,
- Separation of the centers (the "doers") from donors (the "funders") through the establishment of the CGIAR Fund,

- Creation of the CGIAR Consortium as a legal entity with a centralized office, and
- Changing the Science Council (SC) to an Independent Science and Partnership Council (ISPC) with a broader mandate (later becoming the Independent Science and Development Council, ISDC).

On the positive side, the CRPs did improve collaboration among Centers and with external partners. Some important new work was launched (Holderness et al., 2021), notably in areas such as nutrition (the A4NH CRP), climate change (the CCAFS CRP) or crops such as rice (GRiSP/RICE CRP). The Excellence in Plant Breeding initiative resulted in more focused breeding product design, use of novel technologies and shared services across different Centers and crops. On the negative side, external reviews of the CRPs found that the basic weaknesses of the CGIAR system had not been overcome (Birner and Byerlee, 2016; Holderness et al., 2021). The emphasis on greater collaboration through the CRPs did not necessarily lead to better science or to higher returns on spending and the CRPs were quietly abandoned without a rigorous effort to explain how they failed (Holderness et al., 2021). The system's productivity and diversification of successes among commodities, regions, and production systems have not improved. Diversion of funds from research to development work may even have slowed innovation in areas of strategic importance (e.g., genomics, yield potential, nitrogen and water efficiency), while some major themes have never demonstrated significant economic impact (e.g., much of the research on livestock, gender, nutrition, natural resources management, climate mitigation/adaptation; the great majority of the R4D projects managed by the Centers).

The CRP reform further failed in its goals of increasing the size of the Consortium and of raising more unrestricted funding. CGIAR revenue rose from US$735 million in 2011 to a peak of US$1089 million in 2014 but fell to US$736 million in 2020 (Fig. 4).[3]

Consortium management became more complex and bureaucratic than what had been promised at the beginning of the reform in 2008–09 (Fig. 5). The new layers of administration became an exercise in completing log frames and budget templates. The larger Centers, for example, besides managing 100–150 bilateral projects from many funders, now also had to plan, manage and report across the many CRPs in which they participated, and while a 2% tax on bilateral funds which they raised themselves. The central administration, with offices in Montpellier and Rome, grew more expensive and never added value.

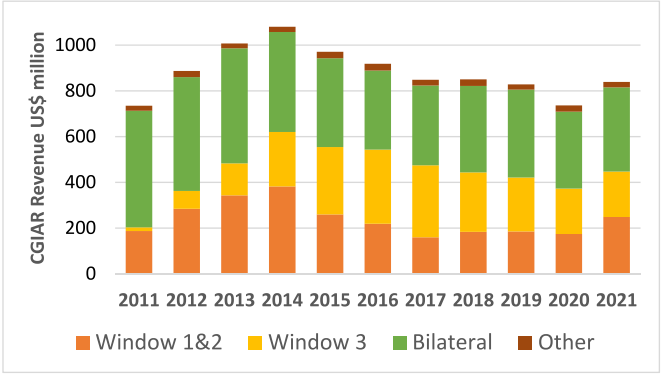

Fig. 4. CGIAR revenue trends during 2011–2021. Source: CGIAR website.

2.1. One CGIAR

The system began another overhaul in 2019—One CGIAR—which promised: (1) a 2030 Research Strategy having a common mission in five impact areas (CGIAR, 2020a); (2) a unified governance system with a single Board, to be the single governance body for the centers and the system organization; (3) institutional integration of centers in terms of structure, policies, and services; (4) new layers of regional and thematic management; (4) a portfolio of large integrative projects; and (5) more resources in general and unrestricted funding in particular (CGIAR, 2019). The objectives were not too different from those of 2008, but the practical outcome is a One CGIAR with less selectivity, less science and even more bureaucracy.

2.1.1. Research

The strategy does not set priorities. Today's One CGIAR continues the errors of venturing into poorly defined areas of low priority and of spreading resources thinly. One CGIAR moved from 16 CRPs to 31 new initiatives funded in 2022 and 2023,[4] spreading money and scientists' time across fields of low priority and limited impact. There is no discernible logic in how the new portfolio was constructed. The resulting large number of initiatives appear to be driven by donor and Center interests, not by scientific or economic value. Many initiatives built on or integrated existing work as centers rushed to maintain ongoing interests or to join as many programs as possible, in the hopes of collecting new funds. The majority of the 31 initiatives have between 7 and 12 participating Centers; six Centers (Bioversity, CIAT, CIMMYT, IFPRI, IITA, IWMI) have spread themselves across 20 initiatives or more. It is improbable that those institutions have the scientific expertise required for such a broad scope of work. In evaluating the proposals for One CGIAR Initiatives in 2022–23, the ISDC defined 17 criteria and spent more than a year on reviewing and scoring these proposals. In the end all proposals were approved and funded, regardless of their scientific merit, comparative advantage and measurable development benefits, and despite of the ISDC's critical comments on the portfolio (ISDC, 2021).

The One CGIAR research strategy does not reflect the system's comparative advantage. While food security, nutrition, and climate change have been and should remain CGIAR priorities, the resources deployed on areas such as gender, youth, inclusion, migration, resilience, urbanism, agroecology and poverty reduction are so poorly allocated, or are so vaguely targeted, that their incremental value is generally negative – and they limit the resources available for work on germplasm, agronomy and climate adaptation. How the promised expected returns of 10:1 and numerous illustrative impacts (CGIAR, 2021) will be achieved across these diverse areas is not evident.

The new portfolio moves further into research and development areas where the CGIAR has no unique expertise. Urban agriculture, migration, agricultural marketing, digital agriculture, or sustainable diets are surely important areas, but the CGIAR has no comparative advantage there compared to many national and regional institutions or others. Several programs— e.g., "Excellence in agronomy," 'Sustainable intensification," "Nature-positive solutions" or "Transformational agroecology"—overlap and seem to have been supported only to distribute resources more widely among IARCs. The livestock research pursued in two initiatives has little scientific content and consists largely of a rehash of unsuccessful development programs. The rationale and operational mechanisms for six under-funded regional development initiatives (in addition to 25 other thematic initiatives working in the

[3] https://www.cgiar.org/food-security-impact/finance-reports/dashboard/overview/; Window 1 and Window 2 refer to centrally managed Trust funds for specific Consortium Research Programs (CRPs) or platforms, which were only partly comparable to previous "core" or "unrestricted" funding. Window 3 refers to direct trust fund allocations to Centers by donors, usually committed for specific projects (e.g., RD4.) Bilateral meant funds raised directly by the centers which did not pass through the Trust fund.

[4] https://www.cgiar.org/research/cgiar-portfolio/. The "Plan of Results and Budget 2022–24" documents of these initiatives can be found at https://www.cgiar.org/research/plan-of-results-and-budget/.

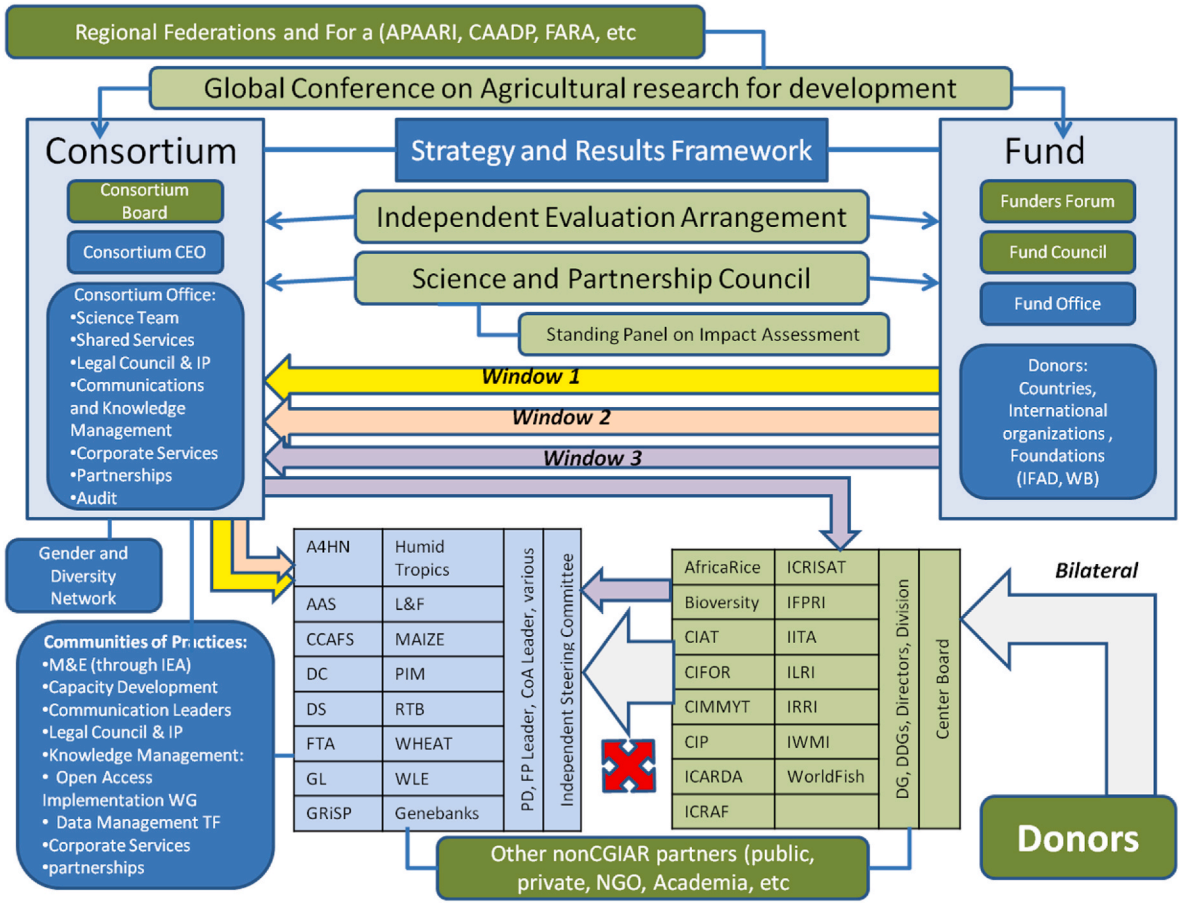

Fig. 5. The real structure of the 'reformed' CGIAR in 2015. Source: constructed by Bas Bouman and the authors.

same regions) are not strong. The opportunity cost of the 2022–23 portfolio is therefore significant in terms of foregone research output in the historical areas of high impact and in failing to confront explicitly the long-term failures of many centers.

Much of One CGIAR's climate work lacks impact, claiming mitigation or adaption benefits that do not exist and may probably never exist. Many of the interventions followed so far were identified decades ago or recycled from temperate agriculture and re-labeled as CGIAR innovations. There has been a general tendency to project large benefit streams (Ramírez Villegas et al., 2021), while evidence about the real benefits of carbon farming, climate smart agriculture or other measures is often lacking at scale. For example, conservation agriculture in South Asia – now often promoted as 'Climate Smart Agriculture', has been studied for over 30 years. In paired on-station or on-farm comparisons, benefits in terms of yields, profit, water use efficiency and greenhouse gas emissions have been shown, but even partial adoption may have only reached 2.5 million hectares by now (Jat et al., 2020). It is thus questionable to speculate about the benefits of a 50% adoption by 2030, as done in Jat et al. (2020) or by others. But good examples also exist for what the CGIAR should do more. For example, the targeted development of submergence-tolerant rice through genetic discovery (Xu et al., 2006) and molecular breeding (Mackill et al., 2012) has led to measurable and relatively fast impact (Bairagi et al., 2021). Overall, while the CGIAR has mapped the major climate risks (temperature, drought, flood, soil health) it does not invest enough in testing novel methods with real mitigation or adaptation benefits.

Much of One CGIAR's portfolio exaggerates the actual and potential benefits of research for rural women. Repeating "gender" and "women" in proposals and social media campaigns is not the same as generating technical, policy, or institutional changes that will actually benefit women in low- and middle-income countries. The CGIAR has only a small residual comparative advantage in gender research. The much broader questions about improving women's status, agency and productivity in rural areas have well-established answers from Boserup (1970), Folbre (1986), and Doss and Quisumbing (2020), *inter alia*. The answers are: (a) provide equal education, health, and technical services; (b) reduce, with the goal of eliminating, gender bias in access to land and other rural capital; and (c) strengthen women's agency in household and collective decision-making and in policy development and implementation. Providing these answers involves local solutions — land reform to benefit African women confronts literally thousands of different situations — that can be provided by local groups supported by assistance from national governments, development banks, the UN agencies, NGOs, the private sector, and others. These solutions require very little additional research from the CGIAR except for methodological support to studies of policy interventions.

Reporting on activities and projected outcomes has outpaced reporting on science and real impact. The 2022 Annual Technical Reports for the new CGIAR initiatives[5] mainly feature theories of change, work package structures, activities, progress traffic lights, and counts of results, innovations, users, knowledge product types, contributors and external partners. It is not quite apparent what anyone can do with that kind of 'dashboard' style information. What is widely missing in the reports, however, are indications of new scientific discoveries, innovation or evidence of field impact.

[5] Available at https://www.cgiar.org/2022-cgiar-technical-report/.

2.1.2. Governance

We have not updated Fig. 5 to show the current One CGIAR structure because it would become too unwieldy to display. A summary of One CGIAR system functions demonstrates its complexity (CGIAR, 2020b). The principal elements of Fig. 5 remain (some have been renamed), most have grown, and costly new layers have been created at the "CGIAR System Organization" level.

The current structure and bureaucracy misunderstand how science really works. They project a false sense of centrally plannable outputs, outcomes and impact that is heavy on jargon, but has little to do with scientific innovation and the inherent *ex ante* uncertainty of research payoffs (Huffman and Just, 2000). Direct intervention in research by "administrators" is often counter-productive because scientists' time is taken from productive activities, which particularly affects the best scientists (Huffman and Just, 2000). "Donors want more oversight, more prescription, more reporting, more short-term projects, and more strategic reviews. This desire for more control is well intentioned but results in scientists spending more time on proposals, reports, and meetings, and less time on science. In addition, since research is almost always done in specific projects, CGIAR scientists have almost no time to more freely pursue their own ideas and hypotheses" (Lobell, 2020). Increasing demands on scientists' time, onerous reporting and budget uncertainty are all disincentives for scientific effort. They have been the chief complaint of the scientists working in the CGIAR since the decline of unrestricted funding in this century. Excess bureaucracy will lead to lower scientific returns and to a brain drain out of the CGIAR.

The addition of new layers of management will further damage scientific efficiency. The CGIAR website now lists dozens of Managing, Global, Regional and other Senior Directors or managerial posts appointed in recent months, including many coming from within the CGIAR.[6] What value they add to the work of the Centers is never stated. Central management and governance cost for the system entities was budgeted as US$60 million in 2022; that amount is 7% of the estimated 2022 total CGIAR expenditures of US$850 million and is expected to be at least as high in 2023 and 2024. At least US$30 million of the US$60 million in system management costs is – in our opinion - unnecessary and accounts for roughly 10% of the total 'unrestricted' funding in 2022; if one accepts an average 10:1 benefit: cost ratio (Hurley et al., 2014; Alston et al., 2022), this, annually, represents lost economic benefits of US$300 million.

Another anticipated outcome was a diminished role and authority of the research centers, although they are the widely known symbols of the CGIAR and its working scientists and technicians. Centers (and the scientists working in them) rely on privileges and support provided by their host countries, which, in most places, have not been granted to the CGIAR System Organization. Besides that, various other center functions cannot be centralized effectively, including fundraising for bilateral resources, partnerships, and asset management. Recently, in hindsight, these shortcomings have been realized and a new Integration Framework Agreement was signed to return much of the previously 'lost' authority to the centers (CGIAR, 2023). The IFA recognizes the centers as independent legal entities with their own specific mandate and governance, and now refers to the CGIAR as an Integrated Partnership of the centers and the CGIAR System Organization. This is a welcome reversal compared to the originally proposed One CGIAR form of governance, but it also illustrated a striking lack of understanding and inclusion of the host countries in the intended reform process. In essence, the Integration Framework Agreement reduces the role of the centralized CGIAR System Organization, but there is no indication that this will lead to the necessary reductions in the size of the central governance and management structures, to improved priority setting or to a greater scientific focus across the system.

[6] https://www.cgiar.org/senior-leadership/.

Funding

Current funding projections for One CGIAR indicate little change. The pattern of restricted funding, with attendant high transaction costs, is repeating itself in One CGIAR. In 2022, funding allocated to 31 new research initiatives was US$246 million, which rose only slightly to a projected funding of US$270 million in 2023. These amounts generally constitute <30% of annual center expenses, with the balances coming from long lists of bilateral projects. A secondary effect of the inability to set priorities is a fragmentation towards small efforts. Of the 2022 (2023) initiatives, about 29% (23%) have budgets < US$5 million; there are 19 initiatives in which the average annual amount per center is less than US$1 million. Anyone involved in agricultural science knows that these amounts are not credible levels of funding to do the work required and achieve the impacts claimed in these proposals.

The challenges to which One CGIAR has committed itself are far greater than the system's financial resources. An annual budget of roughly US$1 billion – which has not been achieved since 2014 – is too small for achieving the ambitions stated for the five One CGIAR impact areas, including many dimensions beyond agriculture. This capability and investment mismatch makes the projected benefits (Prager and Kruseman, 2022) even less plausible. Besides that, the politics that funder organizations must navigate create problems because they interfere with longer-term research and better governance. The short-term focus of many CGIAR donors further turns priorities from research and toward fashionable development agendas that lack adequate justification. As donors continue to influence program development, they create an incentive for scientists to work on issues that are more likely to be funded than on innovations that identify and solve real problems. Only a few donors have invested substantially in aligning their efforts in specific research areas (e.g., in breeding or agronomy research).

2.2. Why did the various CGIAR reforms fail?

The reforms failed, first, because they concentrated on process and administration ('Form'), not on science and impact ('Function'), and because there was no real structural change that might have enabled more focus and impact (McCalla, 2014). A basic defect in the waves of CGIAR reforms – new centers in the 1990s, restricted funding, collective projects, CRPs under central management, One CGIAR – was the lack of rigorous priority setting. The analysis and recommendations of the 2003, 2008 and 2019 panels say little about scientific priorities (e.g., more wheat compared to more cassava; less forestry or more pigeon pea; more biofortification or more climate mitigation; more biotic stress or more abiotic stress; more on rainfed areas compared to irrigated; more on sub-humid Africa compared to arid Africa). The absence of a workable management information system to account for research allocation by commodity, problem, discipline, or research location makes priority setting even more intractable. It also increases the risk of vision and reality not being aligned in CGIAR research (Thornton et al., 2022).

The CGIAR's priority setting has been weak, repeatedly ignoring key evidence for decades. Of particular notice here is that the findings from the major *ex ante* or *post ante* impact assessment studies done across the CGIAR (Raitzer and Kelley, 2008; Renkow and Byerlee, 2010; Wiebe et al., 2021; Alston et al., 2022) were excluded when it came to allocating resources, apparently because those findings did not fit with the prevailing views of the system's managers and donors. For example, a widespread view emerging since the 1990s was that agriculture must "diversify" and that therefore productivity increases in major staple crops such as rice, wheat or maize should also receive less attention in the CGIAR. This view was often in contradiction with the CGIAR's own analysis. An *ex-ante* assessment done by IFPRI (Braun et al., 2008) showed that the biggest benefits were expected in revitalizing yield growth in the intensive cereal systems of Asia, in climate change and adaptation research, controlling wheat rust, developing drought-tolerant maize for Africa, integrated crop nutrient use for

increased productivity, or crop biofortification. Attempts to design the CGIAR research portfolio based on such findings were generally blocked or avoided. The reforms of the CGIAR have financially benefitted the newer "Expansion" Centers, which in recent times received about 35% of the CGIAR's funding, whereas the share of the Centers with the greatest impact declined or stagnated (Fig. 3).

A second reason is that the reform advocates, and the system's governors and managers charged with carrying out the recommendations, failed to make hard decisions. They treated each Center (problem, country, donor) or program as if it were of the same scientific and development importance.

A third reason is that many of the External Program and Management Reviews (EPMRs, 1980–2008) and all of the more recent CRP evaluations (2015–2020) contributed less than they should have because they: (1) highlighted obvious lessons that did not require costly reviews; (2) focused on management, not on science; (3) did not analyze the research production function from funding to impact to identify why some subprojects succeeded and others failed; (4) ignored major scientific problems at Centers and across programs; (5) accepted weakly-supported claims of impact from the Centers and CRPs; and (6) in some instances hid mismanagement from external scrutiny or allowed Centers to manipulate review findings (McIntire, 2023, sections on evaluation in the CGIAR). To make matters worse, recommendations made by the reviews were often of little relevance to impact, or, if they were relevant, were disregarded by the governors and donors.

A fourth reason was the refusal to impose accountability (on those writing the evaluations and on those receiving them). Many of the same people responsible for them still occupy leading positions in the current One CGIAR, or they rotate among Center Boards or other CGIAR bodies.

2.3. What should be done?

Two decades of CGIAR reforms have not solved the system's problems. While One CGIAR now – after more than two years of expensive meetings and consultations – has returned to a model[7] of Centers with independent governance and management, its bureaucracy refuses to recognize that (i) many Centers and programs still have little or no economic impact, (ii) transaction costs have risen, (iii) project preparation methods are not rigorous and damage scientific quality, and (iv) R4D should largely be devolved from the CGIAR because it can be done by the NARES, who have benefitted from decades of capacity development efforts over the past 50 years.

We are aware that these are painful admissions to make, but we also believe that failures provide an opportunity for significant improvement. In what follows, we make suggestions rooted in the CGIAR's unique strengths: (i) access to global genetic resources, (ii) outstanding scientists with decades of experience, (iii) experimental facilities in all major agricultural environments with capacity for systematic long-term data collection and analysis, and (iv) dense networks of national and international partners in the public and private sectors.

2.3.1. Research

The first step is to focus on innovative science, not on technology transfer. The CGIAR should renew its efforts where it has a comparative advantage—by comparative advantage, we mean the capacity to produce superior crop breeding materials and other scientific innovations that can be adapted by local partners for use by farmers. Because the major cereal, legume and oil crops will continue to provide most of the world's food and nutrition (Smith et al., 2022) in the next 20–30 years, the greatest potential for renewed impact is in increasing productivity and nutritional quality on existing cropland. Cereals alone provide more than 40% of the carbohydrate, protein and fiber in food, and similar proportions of other critical nutrients (Smith et al., 2022). A recent study found that faster productivity growth in rice, wheat and maize would increase economy-wide income in developing regions in 2030 b y US$59 billion, US$27 billion and US$21 billion respectively, followed by banana and yams with increases of US$9 billion (Wiebe et al., 2021). Raising productivity, while adapting the major crops to climate change, will also result in large human nutrition benefits (Poole et al., 2020; Smith et al., 2022). Higher rates of productivity growth will reduce, or eliminate, further land expansion or land use change (Stevenson et al., 2013; Villoria, 2019; Folberth et al., 2020; Balmford, 2021). The benefits of productivity for climate and biodiversity will be greater than those expected from the narrow "environmental" initiatives currently being pursued by the CGIAR.

The CGIAR can be a world leader in scientific innovations for precision breeding and agronomy in the major food crops, but it can only do so by focusing its emphasis on those domains, and through collaboration with others. Accelerated breeding to raise yields and protect against heat extremes, drought, flooding, evolving diseases and pests will be ever more important, as will be science for site-specific, digitally supported agronomy solutions (Lobell, 2020). Although in some crops or world regions such gains can be achieved by the private sector or strong NARES, a major investment in leading food crops by the CGIAR, along with national partners, would help to ensure that poor farmers can quickly benefit from these advances (Lobell, 2020). In translational crop research different areas of science – from molecular biology to breeding and agronomy – must be pursued in close interaction in order to achieve sustained productivity and efficiency gains over time, which also leads to identifying new challenges to be tackled (Sadras et al., 2020). The evolution of wheat farming in the Yaqi valley of Mexico (Fischer et al., 2022) provides an example for that, including the role of the CGIAR and its partners.

Broader objectives for producing more nutrient-rich food should also be embedded in this strategy rather treating them separately, as currently done. This includes exploiting novel scientific approaches for addressing both sides of the double burden of malnutrition: undernutrition and overweight and obesity (Popkin et al., 2020). For example, future generations of rice varieties may not just be well-adapted to a hotter climate but may also have significant improvements in eating and nutritional quality, including more protein, lower glycemic index, or enrichment with numerous micronutrients (Sreenivasulu et al., 2022; Pasion et al., 2023). Genome editing will also enable achieving broad spectrum resistance to major crop pests and diseases, such a bacterial blight in rice (Oliva et al., 2019). CGIAR Centers with their outstanding expertise, genetic resources, global and regional collaborative networks, and in many cases track-records of substantial crop impacts, are ideal platforms to pursue such innovations, but more of the CGIAR's resources need to be focused on that.

Create an expanded global crop improvement network. Following the above and building on earlier calls made in the CGIAR (Reynolds et al., 2017), an expanded global crop improvement network should consist almost entirely of productivity-enhancing, climate adaptation research. This requires allocating more resources to generic priorities for raising farmer productivity as to activities directly focused on climate adaptation and mitigation, including abiotic stresses and resistance to evolving pests and diseases. At the core of such work, we propose a new field research network integrating genotyping, phenotyping, agronomic and environmental mapping to deliver climate change-ready crops and agronomic practices in less time. A dedicated network dedicated to climate adaptation for crop productivity growth, targeted on temperature, moisture, nutrient, disease and other growing period constraints in would have far greater impact than half-hearted and overly prescriptive efforts scattered across many work areas that now characterize One CGIAR's initiatives.

Besides specific genetic improvement targets in staple food crops (e.g., yield potential and resilience, heat tolerance, multi-stress tolerance, etc.), this network would include microbial and gene editing technologies, as well as groundbreaking precision agronomic research on

[7] The "Integration Framework Agreement".

improving nutrient and water efficiency and reducing greenhouse gas emissions. Working across well-controlled "field laboratories" in the major agroclimates, common protocols with live uploads of all data would ensure immediate and open access. The Accelerated Breeding Initiative as well as the Excellence in Agronomy Initiative of the One CGIAR contain valuable elements of what is needed in such a network, working with the same scientific approach across different crops and environments.

Invest in "discovery research which might produce breakthroughs in high priority areas. Field application of ideas such as engineering C4 photosynthesis into rice (Ermakova et al., 2021), developing *N*-fixing cereals (Good, 2018), or creating 'smart" fertilizers with plant signaling mechanisms for triggering nutrient release (Lam et al., 2022) could become feasible within the next decades, but such research requires strategic collaboration and adequate resources, including investment by the CGIAR. Research is also needed on respiration, roots and hormone cross-talk in regulating source-sink relationships in major crops, which is fundamental to increasing yield potential, raising tolerance to heat stress, and improving other plant traits (Reynolds et al., 2021). Unraveling the genetics underlying micronutrient signatures in major staples (Pasion et al., 2023) or utilizing gene editing to transfer traits from nutritious local crops to widely grown staples (Singh et al., 2022) provide new opportunities for creating more nutritious cereals and other food crops. Understanding the soil-plant microbiome (Tkacz and Poole, 2021) represents another opportunity to bolster soil health (Hartmann and Six, 2023) or to improve climate adaptation in plants (Trivedi et al., 2022).

We do not propose that the CGIAR should invest large proportions of its funds in such discovery research. We argue, however, that this must also be an integral component of a strategic research portfolio, targeting specific challenges. Besides their longer-term impact potential, such more upstream research projects create scientific excellence and attract collaboration with the best scientists in the world, which is essential for the CGIAR (Coffman et al., 2020). They also inspire the CGIAR's national partners, attract and train new talent, and lead to large spillover effects of the new knowledge being generated, for example to plant breeding. It is a tragedy that the One CGIAR is currently so sluggish in these new areas.

Another step in restoring the CGIAR's impact is to cut involvement in technology transfer and development projects. It is true that the CGIAR should align its strategic research closely with national partners to test early innovations. It should refrain, however, from leading development projects or extension efforts. The capacities of public and private national programs are more than enough to do adaptive research and extension, with support from regional collaborators as needed. While the CGIAR will always rely on national partners to achieve adequate scale, local and regional institutions, including the private sector, will always have a comparative advantage in development work. Partners have assets that dwarf the One CGIAR budget and failing to respect national and regional program capacities is a waste of scarce resources.

We do recognize the different capacities of the national programs. The larger programs (e.g., Brazil, China, India, Indonesia) have financial and human capacities that are much larger than those of smaller countries in Latin America, Asia or sub-Saharan Africa. While the CGIAR's strategy has long focused on sub-Saharan Africa and its partnerships are adapted to the strengths of the larger NARES, it is important that the CGIAR's efforts do not duplicate what collaboration among larger and smaller NARES can achieve and that those efforts are not invested in themes that do not require international research.

Stop research in areas of low impact and comparative disadvantage. Of the current "CGIAR initiatives" portfolio, the six regional initiatives and perhaps 15 of the thematic research initiatives are either low impact or can be done by the national programs or others. This includes, for example, most of the tropical livestock development and local natural resources management. Programs in aquatic food systems, urban and peri-urban agriculture, ecology/agroecology, conflict and migration, markets and policies, and conservation of biodiversity should be removed from the CGIAR portfolio and devolved to the national programs or the specialized UN agencies. National and regional programs can assume most of the work on nutrition and health given that it now consists largely of extension and because it relies heavily on integration with local efforts in public health, sanitation, and education (Becquey et al., 2022; Nisbett et al., 2023).

Gender. The CGIAR should accept that research has found most of the technical and policy answers needed to improve the lives of rural women and that the impact of the CGIAR's gender research has had very little impact. The chief remaining question — how to apply those answers? — is only a small part of the mandate of the CGIAR. Application of such knowledge can be done through local initiatives supported by national programs, NGOs, specialized UN agencies, development banks and foundations. Where the CGIAR works on specific innovations such as new crop varieties or agronomic practices, a minimum of focused gender research must be an integral element, ensuring that the products being developed meet the local needs or at least do not increase the burden on women or children.

2.3.2. Governance

The signing of the CGIAR Integration Framework Agreement (CGIAR, 2023), which respects the legal status of the Center-host country agreements and re-affirms the scientific and managerial autonomy of the centers, is a de facto admission that the originally envisaged One CGIAR governance structure has failed. The next logical step in restoring impact is to dismantle the centralized, unwieldy and expensive 'matrix' governance and management structure and replace it with something much simpler.

An efficient CGIAR system organization should complement the centers by (i) ensuring strategic focus without micro-management, encouraging unrestricted fundraising, and stressing high-level communication, (ii) providing a few shared policies and services (e.g. financial management, human resources), (iii) enabling more transparent and accountable flows of funds, (iv) stimulating scientific interaction (seed grants, blue sky grants), and (v) simplifying reporting and other transaction costs that hamper science.

Specific actions include.

- Cut the number and costs of One CGIAR initiatives to a few priority programs that represent the strengths of the system;
- Halt all other 'development' initiatives and re-allocate their funds to the fewer priority programs, or devolve them to development agencies, such as FAO, IFAD and the AfDB;
- Reduce the number of centers to those that make real scientific contributions to the re-focused core programs. A rigorous programmatic adjustment will inevitably make some centers redundant or encourage mergers or more effective research. Such centers may of course continue their work outside the CGIAR and be funded directly;
- Reduce the central CGIAR management and its related entities and re-allocate their money to real science. This could liberate at least US $30 million annually from the system's current bureaucracy;
- Replace the current ISDC with a high-level, independent, scientific body on science (no development) priority setting in order to reduce biased donor influence and create better incentives for research on problems of high importance;
- Change foresight, monitoring and evaluation to avoid unrealistic theories of change, overblown impact expectations and meaningless bean counting.

Funding

The CGIAR requires a funding model that provides sustainable, multi-year funding, while allowing for new ideas and paying for sustainable capacity (e.g., infrastructure, equipment, gene banks, long-term

trials, field networks, etc.). Core donors could manage pooled funding to guarantee (i) performance standards, (ii) minimizes interference and bureaucracy, and (iii) ensures business as well as science continuity, particularly for the scientists and staff doing the actual work. Increased and more stable funding of fewer core programs and institutions would also motivate centers to stop chasing development money that creates mission drift and raises transaction costs.

We propose that donors could put their funds into three baskets: (A) one to support centers' infrastructure, facilities, core operations and other core capabilities that represent major public goods (e.g. gene banks, other collections, long-term trials, etc.), (B) one to fund programs executed by centers and their partners under the re-focused CGIAR research strategy, and (C) one to fund exploratory new science ('blue sky', 'new frontiers') and to accelerate specific innovations towards broader use. Funds for associated capacity building (students, young scientists) should also be included. The proportions of these three baskets may vary over time, but a good starting point would be about 30% (A), 60% (B) and 10% (C) of the current total Window 1, 2 and 3 investments (ca. US$450 million). Within or in addition to baskets (B) or (C), there may also be special opportunities for larger donors to step up their efforts and fund specific grand challenges. For example, the proposed new network for climate change adaption/mitigation research could be financed by endowing a fund with at least US$250 million over five years, for example by taking the annual World Bank CGIAR contribution of US$30 million and adding an exceptional contribution from net income of US$100 million into a trust fund in year one.[8]

Generally, to qualify for baskets (A) and (B) a center must be 'CGIAR accredited', which requires that each center will be reviewed every 5–7 years and measured against the highest performance standards in terms of science, management and governance. Basket (A) allocations would consider the different character and size of a center's footprint and operations. Basket (B) would be allocated to about 10–12 strategic research programs (5-year, renewable) that together represent a coherent and rigorously re-focused portfolio of the CGIAR. Allocation of basket (B) to different programs must be strictly based on relevance (problem definition, unique CGIAR role, impact potential) and science quality (novelty, feasibility). It should follow a simplified but more rigorous proposal development and evaluation process than previously done for the CRPs or the new One CGIAR initiatives. Many of the basket (B) programs may get renewed every five years upon re-evaluation, whereas others may phase out and become replaced by new ones as the results have been achieved or new priorities emerge. Important is that the portfolio remains concise, avoiding mission drift and thin spreading of funds. Basket (C) would purely be allocated on a competitive basis, applying proposal evaluation standards that are common in many science funding bodies around the world. Typically, such proposals would also require collaboration with outside science partners, or even the private sector. A key rationale for creating (C) is that in the national science funding bodies of many countries CGIAR Centers are not eligible to lead proposals for more upstream research, which limits their ability to work in such areas.

This proposed mechanism is not new. It is, for example, similar to how strategic research institutes are funded in the UK or in Germany. It recognizes the unique role that such institutes play in the R&D environment (compared to universities, private sector or others) and it recognizes the fundamental strategic and operational needs of such institutions. It keeps bureaucracy at a manageable level, because it involves a closer relationship between the funders and the institutes, resulting in deeper knowledge, mutual respect and a higher level of trust.

[8] World Bank allocable income averaged US$1.16 billion annually over its fiscal years 2018–2022. Some 72% of the Bank's allocable income in those years was put into its general reserve. Transferring another US$20 million annually is therefore about 2.4% of additions to the general reserve.

2.3.3. Final thoughts

People reading this paper may of course ask what can be done now, considering that the One CGIAR has swung into motion. We hope that at least some will be stimulated to pause and think, rather than simply accept the status quo and wait for another reform to follow more than 20 years of previous reform efforts. Our aim is to guide towards better science and greater impact. We know that our proposals could be interpreted as reverting to the "unrestricted" CGIAR of the 1970s and 1980s, but that is not our intention. Much progress has been made since then in agriculture, there are new development challenges, and science has evolved rapidly. We firmly believe, however, that scientific advances in the CGIAR and the impact from them could be much bigger if there was a narrower scientific focus, more rigorous project selection, less bureaucratic interference, and a funding system that encourages creativity above filling in meaningless templates. In that sense many of our recommendations are similar to those made, yet never acted upon (Lele, 2004; McCalla, 2014), but they are more urgent given that two decades and billions of dollars have been mis-spent.

Implicit in our recommendations is a strengthening of the 'legacy Centers' which have been and will continue to be the primary sources impact for the CGIAR. These legacy centers would be better equipped to do research and collaborate with their partners based on real needs, scientific capabilities, and demand. They would also engage with major companies and academia in pre-competitive research so that the science bar is raised across the board but remains focused on problem solving.

We believe that the CGIAR scientists are highly motivated and try to do the right thing, but they do not have the right enabling environment in which to succeed. The CGIAR's governors, managers and donors in particular should feel a strong responsibility to correct that. This is a great opportunity for the CGIAR and the revolution we seek.

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Opinions expressed in this paper are our own. They do not reflect the views of any organization we work for or interact with or have done so in the past. We thank several colleagues for their comments on earlier drafts. John McIntire has worked as a Principal Economist at ICRISAT (1980–1984) and ILCA (1984–1989), Country Director and Sector Director in the World Bank (2000–2011), Director of Research at ILRI (2012–2014), and Associate Vice President of IFAD (2014–2015). Achim Dobermann has worked as Soil Scientist at IRRI (1992–2000), Professor at the University of Nebraska (2000–2008), Program Leader, Deputy Director General for Research and CRP Director at IRRI (2007–2014), and Director & CEO of Rothamsted Research, UK (2014–2019). He is currently a Consultant and the Chief Scientist of the International Fertilizer Association (IFA).

Data availability

No data was used for the research described in the article.

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